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Use of a Caterpillar 527 tracked grapple skidder on soft terrain in northeastern Ontario

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Abstract

The environmental impact of forest operations is a growing concern. This report describes FERIC's observations of a Caterpillar 527 tracked grapple skidder, which offered promising results in limiting ground disturbance, but whose use is best restricted to soft terrain.

Introduction

Concerns about ground disturbance during harvesting operations have led to the development and testing of purpose-built machines intended to operate on soft ground throughout the year. FERIC briefly studied one such machine, the Caterpillar 527 tracked grapple skidder (Figure 1), working in a full-tree harvesting operation for Rosko Forestry Operations Ltd. northeast of Kirkland Lake (Ont.) in August 1999. The study's goals were to assess the machine's productivity and its ability to operate on soft terrain.

We observed the skidder working on a variety of wet sites where wheeled skidders would have experienced trafficability problems (CPPA terrain classification 4(3).1.1). Soils varied from loams to clay loams, and it had rained hard in the days before the study. The moss-covered organic layer was generally less than 15 cm deep, with no rocks present, and slopes never exceeded 10%.

Figure 1. The Caterpillar 527 tracked grapple skidder, with a swing boom.

Machine description

The Caterpillar 527 is based on a tracked dozer. The unit observed used an Esco model 110 grapple on an articulated swing-boom, which lets the operator load and unload without having to "skid steer" off of the trail. The undercarriage's raised drive sprocket is located further to the front than in traditional dozers so as to improve the machine's weight distribution and balance. The track's 88-cm-wide shoes have an additional outer set of links to strengthen them against torsional loads. With an operating weight of 21.5 tonnes (unloaded), the static ground pressure is approximately 15 kPa (6 psi). The blade functions similarly to that of a conventional dozer.

Study results

Table 1 presents the results of our detailed time study (15.1 PMH) and the estimated productivity for a standard extraction distance of 150 m. Overall productivity was excellent, and was within the expected range for a wheeled skidder on firm ground. Travel speeds were high, averaging 89 m/min (5.3 km/h) empty and 71 m/min (4.3 km/h) loaded, mainly in first and second gear. On some sections of the trail, speeds reached 145 and 130 m/min (empty and loaded, respectively), probably as a result of using third gear.

Loading times depended on the number of bunches required to make a load; one bunch was enough 55% of the time. Loading a single bunch was most efficient, since accumu-

Table 1. Time study results and productivity

Work cycle element	Time (min)
Travel empty	1.68
Maneuver	0.41
Load	0.59
Move during loading	0.31
Travel loaded	2.10
Unload and deck	1.17
Delays	0.72
Total cycle time	6.98
Extraction distance (m)	150
Avg. trees/load	17.9
Avg. stem size (m^3)	0.184
Avg. load (m^3)	3.3
Avg. productivity (m^3/PMH)	28.4

lating two bunches required three separate maneuvers: acquiring a first bunch and laying it parallel to the trail; acquiring a second bunch and laying it atop the first; and finally, picking up both bunches together. This emphasizes the need to create bunch sizes that match the skidder's load capacity (around 3 m^3) during felling. Large bunches that had to be split into two loads also increased loading times. Loading was fastest when the bunches were positioned on the skidder's right side, since the operator's seat is mounted at slight angle to the right and does not rotate. Loading times could be further reduced by placing bunches of trees parallel to the trail rather than at an angle while working toward roadside.

Decking times were greater than average for a grapple skidder. The swing boom lets the operator efficiently drop the load at the side of the machine, but the subsequent decking of the trees with the skidder's blade was time-consuming. However, the machine's blade, which could tilt and change angle, permitted more precise decking than conventional skidders can achieve.

Ground disturbance

FERIC assessed ground disturbance levels in the study area. The results were good: 57% of the area was undisturbed, with only mild disturbance of the organic layer in 28% of the area. Severe disturbance occurred in 15% of the area, comprising mixed mineral and organic soil (7%) and mud (8%). The cutover showed no deep (>20 cm) rutting, but mud occurred where the skidder crossed alder and Sphagnum areas and the tracks sank to some extent. Skid steering also created disturbance where the driver turned sharply, such as at the landing, but the operator used the same turning points along the designated trails while working on the cutover.

Implementation

The Caterpillar 527 grapple skidder was productive and produced relatively moderate ground disturbance under the study conditions. Although its versatile dozer blade, its swing boom, and its tracks make the machine attractive for wider use, it has been specially designed to operate on soft ground. Thus, its undercarriage may suffer excessive wear on rocky terrain, and the skidder should not be used for traditional road maintenance or construction unless a second set of narrower tracks is installed for that purpose. However, the owner was able to use the skidder to pack down winter roads and for snow removal.

At a cost of $430 000, the direct operating cost (excluding overhead and profits) is around $140/PMH. This equates to a direct skidding cost of about $5/$m^3$ over a 150-m extraction distance, for a 50% increase over the cost of a large wheeled skidder on firm ground. Thus, the skidder should be used primarily where conventional equipment would be unproductive or would produce excessive ground disturbance, or as an alternative to wide-tired skidders. For the skidder to be economical, there must be enough suitable terrain to keep it fully occupied throughout the year.

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